In re Patent Application of
BRANCIFORTE ET AL.
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In the Claims:

Claims 1-13 (Cancelled).

14. (New) A quantum gate for running a Grover's quantum algorithm using a binary function having a basis of vectors of n qubits, the quantum gate comprising:

a superposition subsystem for performing a superposition operation on components of input vectors for generating components of superposition vectors on a second basis of vectors of $n+1$ qubits;

an entanglement subsystem for performing an entanglement operation on components of the linear superposition vectors for generating components of entanglement vectors; and

an interference subsystem for performing an interference operation on components of the entanglement vectors for generating components of output vectors, said interference subsystem comprising

at least one adder receiving as input signals representative of even or odd components of an entanglement vector, and generating a sum signal representative of a weighted sum with a scale factor of the even or odd components, and

an array of adders, each receiving as input a respective signal representing an even or odd component of an entanglement vector and the sum signal, and generating as a difference between the sum signal and a signal representing an even or odd component of an entanglement vector a signal

representing an even or odd component of the output vector.

15. (New) A quantum gate according to Claim 14, further comprising a processing subsystem comprising:

at least one analog/digital converter receiving as input the signals representing even or odd components of the output vector for converting the signals into a digital string; and

a microprocessor unit receiving as input the digital string for calculating a parameter to be made less than a threshold of the digital string of the converted components of the output vector, said microprocessor unit performing the following

comparing the parameter to be minimized with the threshold for stopping the Grover's algorithm if the parameter is less than the threshold, otherwise commanding another iteration thereof, and

outputting a digital string with the reduced parameter representing components of the output vector.

16. (New) A quantum gate according to Claim 15, wherein said processing subsystem further comprises:

at least one digital/analog converter receiving as input the digital string with the reduced parameter for generating output signals corresponding to even or odd components of the output vector; and

an array of inverters, each receiving as input a respective output signal of said at least one digital/analog converter and generating a pair of signals having a

predetermined voltage swing representing opposite components of a new superposition vector that is to applied as an input to said entanglement subsystem.

17. (New) A quantum gate according to Claim 16, wherein said at least one analog/digital converter comprises commercial device ADC0808; wherein said microprocessor unit comprises commercial device XC95288XL; and wherein said at least one digital/analog converter comprises commercial device AD7228.

18. (New) A quantum gate according to Claim 15, wherein the parameter to be minimized comprises a Shannon entropy.

19. (New) A quantum gate according to Claim 16, wherein the quantum gate has a modular architecture and further comprises:

at least one module; and

an internal bus for exchanging data among said at least one module and said microprocessor unit;

said microprocessor unit generating addresses of said at least one module to be enabled for sending or for receiving data from said microprocessor unit via said internal bus, and generating first and second logic signals for respectively enabling said at least one analog/digital and said at least one digital/analog converter;

said at least one module including a respective subgroup of said array of inverters and of said array of adders, and comprising

an identification circuit for generating a relative bit string that identifies a selected module, and

a comparator receiving as input the bit string of the selected module and the address, and generating a flag that enables the module to exchange data with said microprocessor unit if the received address matches the bit string of the selected module, otherwise the selected module is set in a tristate condition.

20. (New) A quantum gate according to Claim 19, wherein said at least one analog/digital converter is enabled by a logic AND between the flag and the first logic signal; wherein said at least one digital/analog converter is enabled by the logic AND between the flag and the second logic signal; and each of said adders comprises a voltage buffer comprising

an operational amplifier having at least one input for receiving a respective input voltage, and an output for providing the sum signal;

a feedback resistor connected between an output and the at least one input of said operational amplifier, and

the corresponding inputs and outputs of said operational amplifiers of said voltage buffers being connected in common.

21. (New) A quantum gate according to Claim 20, wherein each voltage buffer comprises:

a first voltage divider having a first ratio and comprising a first pair of resistors, a first terminal node

coupled to a reference voltage and a second terminal node coupled to the input voltage of a respective voltage buffer;

a second voltage divider having the first ration and comprising a second pair of resistors, a first terminal node coupled to the reference voltage and a second terminal node coupled to the output node of the operational amplifier; and

the at least one input of said operational amplifier comprising a first input connected to the intermediate node of said first voltage divider and a second input connected to the intermediate node of said second voltage divider.

22. (New) A quantum gate according to Claim 21, wherein each of said voltage dividers comprises an identical pair of resistors.

23. (New) A quantum gate according to Claim 19, wherein the input voltage of each voltage buffer comprises a voltage representing a respective even or odd component of an entanglement vector.

24. (New) A quantum gate according to Claim 19, wherein said adder of each module comprises an auxiliary adder for generating a respective partial sum signal representing a weighted sum of a respective pre-established number of even or odd components of the entanglement vector that is input to the respective voltage buffer.

25. (New) A quantum gate according to Claim 19, wherein said entanglement subsystem comprises:

a command circuit for generating a plurality of logic command signals encoding the values of the binary

function corresponding to the first basis of vectors; and

an array of multiplexers, each driven by a respective logic command signal and receiving as input a plurality of signals representing components of a linear superposition vector corresponding to the second basis of vectors having the first *n* qubits in common, and outputting for each superposition vector signals representing components of an entanglement vector, each component of the entanglement vector corresponding to a respective vector of the second basis of vectors is equal to the

corresponding component of the respective superposition vector if the binary function is null in correspondence to the vector of the first basis formed by the first *n* qubits of the respective vector of the second basis, or

the opposite of the corresponding component of the respective superposition vector if the binary function is not a null in correspondence to the vector of the first basis formed by the first *n* qubits of the respective vector of the second basis; and

each module including a respective subgroup of said array of multiplexers and receiving as input the components generated by the respective subgroup of said array of inverters.

26. (New) A quantum gate according to Claim 19, wherein said at least one module comprises a plurality of modules that are identical to each other.

27. (New) A method for running a Grover's quantum algorithm using a binary function having a basis of vectors of n qubits, the method comprising:

performing a superposition operation on components of input vectors for generating components of superposition vectors on a second basis of vectors of n+1 qubits;

performing an entanglement operation on components of the linear superposition vectors for generating components of entanglement vectors; and

for performing an interference operation on components of the entanglement vectors for generating components of output vectors, the interference operation comprising

providing to at least one adder input signals representative of even or odd components of an entanglement vector, and generating a sum signal representative of a weighted sum with a scale factor of the even or odd components, and

providing to an array of adders respective input signals representing an even or odd component of an entanglement vector and the sum signal, and generating as a difference between the sum signal and a signal representing an even or odd component of an entanglement vector a signal representing an even or odd component of the output vector.

28. (New) A method according to Claim 27, further comprising:

providing to at least one analog/digital converter the signals representing even or odd components of the output vector for converting the signals into a digital string; and

providing to a microprocessor unit the digital string for calculating a parameter to be made less than a threshold of the digital string of the converted components of the output vector, the microprocessor unit performing the following

comparing the parameter to be minimized with the threshold for stopping the Grover's algorithm if the parameter is less than the threshold, otherwise commanding another iteration thereof, and

outputting a digital string with the reduced parameter representing components of the output vector.

29. (New) A method according to Claim 28, further comprising:

providing to at least one digital/analog converter the digital string with the reduced parameter for generating output signals corresponding to even or odd components of the output vector; and

providing to an array of inverters a respective output signal of the at least one digital/analog converter and generating a pair of signals having a predetermined voltage swing representing opposite components of a new superposition vector that is to applied as an input to an entanglement subsystem performing the entanglement operations.

30. (New) A method according to Claim 28, wherein the parameter to be minimized comprises a Shannon entropy.

31. (New) A method of carrying out an interference operation of a Grover's quantum algorithm comprising:

calculating a weighted sum with a first scale factor of even or odd components of an entanglement vector; and

generating each even or odd component of an output vector by subtracting from the weighted sum corresponding even or odd components of an entanglement vector.

32. (New) A method according to Claim 31, further comprising:

calculating a plurality of partial weighted sums with a second scale factor, of a certain number of even or odd components of the entanglement vector; and

calculating the weighted sum by summing the partial weighted sums with the second scale factor.